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SCREENING OF SOYBEAN VARIETIES FOR SEED STORABILITY USING ACCELERATED AGEING TEST

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ABSTRACT

Sowing of deteriorated seed leads to sub optimal plant stand and poor crop performance in the field. Hence, maintenance of seed viability and vigour from harvest till next sowing play a vital role in crop production. In soybean, wide variability has been observed for seed storability. Screening of varieties helps in identification of good storers and their inclusion in breeding programmes. Accelerated ageing test has good correlation to storage potential of the seed. In the present study, freshly harvested seeds of 30 varieties/genotypes of were subjected accelerated ageing for 7 days to screen the varieties/genotypes for seed storability. The results showed significant decline in seed germination in all the varieties/genotypes upon ageing. But, the degree of *reduction in germination was varied significantly among* ***varieties/genotypes.*** *Seeds of JS 71-05 completely lost germination after 7 days of accelerated ageing while DS 228, MAUS 61 and NRC 93 recorded 96, 95 and 92 per cent reduction in germination, respectively compared to unaged. Whereas, lowest reduction was observed in Kalitur (44.7%) which is on par with MACS 1416 (52%) followed by DSB 21 (54%), EC 18761 (57.6%), RKS 18 (55.6%) and CO 1 (58.1%).* ***Out of 30 varieties/genotypes tested, Kalitur, MACS 1416, DSB 21, EC 18761 and CO1 were found to maintain maximum seed germination and seedling vigour and considerably less electrical conductivity of seed leachate after accelerated ageing of 7 days. While, JS 71-05, DS 228, MAUS 61, NRC 93 and DSB 24 were maintained least seed quality attributes after ageing.***

KEYWORDS: ***Accelerated Ageing, Seed Germination, Soybean, Storability, Vigour***

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Original Article

INTRODUCTION

Soybean (Glycine max (L.) Merrill) is one of the most important oilseed crops in the world. It is a cheaper source of quality protein and edible oil. The world production of edible oils consist of 30% soybean (Assefa, 2008). In India, soybean is being grown in an area of 12.2 m.ha with a production of 11.99 m. tonnes and productivity of 983 kg/ha during 2013-14 (Agricultural Statistics at a Glance, 2014).

Maintenance of seed viability and vigour from harvest till next sowing is crucial for success of any crop production programme as the sowing of deteriorated seed leads to sub optimal plant stand (Shelar, 2007) and crop performance (Egli and TeKrony, 1979; Pallavi *et al.,* 2003). The potential storage life of seeds varies from species to species (Harrington, 1972) and even varieties of the same species (Agrawal, 1979). Rapid deterioration of soybean seeds during storage is well documented (Burris, 1980). However, large variation is observed among varieties/genotypes in soybean (Kuchlan et al., 2010). In this regard, screening of the varieties for seed storability helps in identifying good storers and including them in breeding programmes.

Accelerated ageing test is a quick test based on increased seed deterioration under hot and humid condition of storage. It has been used to estimate seed vigor and deterioration during storage (Delouche and Baskin, 1973; McDonald, 1999; Modaressi and Van damme, 2003) and has good correlation to field emergence and storage potential of the seed. Kuchlan et al. (2010) reported a wide variability in fall of germination after four days of accelerated ageing in all 15 soybean cultivars tested and germination range was 50-94%. Further increase in ageing period (8 days) lead to significant decline in the germination of all the cultivars causing failure to maintain seed certification standard of 70% germination in most of the cultivars except Bragg, JS 9305, PS 1024 and MAUS 61-2. Kapoor et al. (2011) screened five rice varieties for seed storability using accelerated ageing test. They observed a varietal difference in deterioration of these varieties during accelerated ageing and they identified that sugandha 4 as the best variety followed by saket 370 among five varieties.

In order to evaluate the seed storage potential of different varieties of soybean, 7 days of accelerated ageing period has been standardized in our earlier studies (Vijayakumar and Vijayakumar, 2015). In this context, an attempt was done to screen the varieties/genotypes of soybean for seed storability.

MATERIALS AND METHODS

Seeds of 30 soybean varieties/genotypes which were multiplied in Agricultural Research Station, Bhavanisagar of Tamil Nadu Agricultural University during *kharif* 2014 were used for the screening study. For this purpose, fourty gram of fresh seeds of 30 soybean varieties/genotypes having moisture content of 8.5% were subjected to accelerated ageing for 7 days. Seeds were packed in paper bag with uniform pin head size perforation all over and placed in a sealed ageing glass jar containing sufficient quantity of distilled water to maintain 100 per cent relative humidity and incubated at a temperature of 40 ± 1° C (Delouche and Baskin, 1973). After an ageing period of 7 days, seeds were taken out and tested for following seed quality parameters along with the unaged seed.

Seed Germination Per cent

The laboratory germination test was carried out using 100 seeds of four replication in paper medium (ISTA, 2007). The test conditions of 25 ± 2°C temperature and 95 ± 3 per cent relative humidity were maintained in the germination room. At the end of eight days, number of normal seedlings was counted and the mean was expressed as germination per cent.

Shoot Length

Shoot length of ten normal seedlings from each replication of the germination test was measured from collar region to the shoot apex and the mean was expressed in centimeter.

Root Length

Root length of ten normal seedlings from each replication of the germination test was measured from collar region to the root tip and the mean was expressed in centimeter.

Dry Matter Production

The seedlings used for growth measurement were dried in hot air oven (after removing the cotyledons and seed coat) maintained at 80 ± 2°C for 24 h and cooled in desiccator filled with silica gel for 30 min. The dry weight of seedlings was recorded using an electronic balance and mean was calculated and expressed as g seedling^{-1}.

Seedling Vigour Index

The seedling vigour index was computed by adopting the formula as suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

Seedling vigour index-I = Germination (%) x Mean seedling length (cm)

Seedling vigour index-II = Germination (%) x Dry Matter Production (mg/seedling)

Electrical Conductivity of Seed Leachate (Hampton and TeKrony, 1995)

Four replications of twenty five seeds were drawn, prewashed well with distilled water to remove the adhering particles and the surface water was removed by blotting with tissue paper. Cleaned seeds were weighed and then soaked in pre-cooled 50 ml of distilled water for 9 h at 20°C temperature. After completion of soaking duration, the beaker was swirled for 10-15 seconds and electrical conductivity of seed leachates was measured using Conductivity Bench Meter by immersing dip-type cell of a digital conductivity meter with a cell constant of one. The electrical conductivity of the seed leachate was expressed as µS cm^{-1} g^{-1}.

RESULTS AND DISCUSSIONS

Seeds of 30 varieties/genotypes undergone accelerated ageing for 7 days shown significant variation in ability to germinate and produce vigourous seedlings.

Initial seed germination varied with the varieties/genotypes tested, maximum of 99 per cent of seed germination in EC 18761 and minimum of 79 per cent was noticed in JS 71-05. The present study showed that there was a significant decline in seed germination of all the varieties/genotypes upon ageing from 88.6 per cent (Initial) to 24.9 per cent (after accelerated ageing). However, the percentage reduction in germination was varied significantly among varieties/genotypes. Seeds of JS 71-05 completely lost germination after 7 days of accelerated ageing while DS 228, MAUS 61 and NRC 93 recorded 96, 95 and 92 per cent reduction, respectively. Whereas, lowest reduction was observed in Kalitur (44.7%) which is on par with MACS 1416 (52%) followed by DSB 21 (54%), EC 18761 (57.6%), RKS 18 (55.6%) and CO 1 (58.1%) (Table 1). Initial seedling length varied among varieties/genotypes and it is ranged from 45cm in kalitur to 33.2cm in JS 71-05. Varieties/genotypes tested shown variability in ability to produce vigourous shoot and roots after accelerated ageing. CO 1 recorded lowest reduction in seedling length (which maintained 32.3cm) followed by EC 18761,MACS 1416 and DSB 21 while all the seeds are dead in JS 7105 and drastic reduction noticed in DS 228 (which maintained only 16.0cm), followed by MAUS 61. (Table 1). All the varieties/genotypes tested shown drastic decline in dry matter production also upon accelerated ageing. However, CO 1 recorded lowest reduction in dry matter production which maintained 30.6mg/seedling followed by EC 18761 and MACS 1416. Whereas, highest reduction was observed in DS 228 which maintained only 19.6 mg/seedling, followed by KDS 726 (Table 2).

Both seedling vigour index I and II were reduced upon ageing as result of reduction in seedling length and dry matter production. However, kalitur maintained highest seedling vigor index I & II after ageing (1563 and 1622, respectively) which is on par with MACS 1416 followed by EC 18761 and DSB 21. DS 228 shown lowest seedling vigour index I and II (48 and 59, respectively) after ageing which is on par with MAUS 61, NRC 93 (Table 1 & 2).

The decreased seed vigour is because of reduced capacity to germinate and produce vigorous seedlings which might be due to seed deterioration resulting from accelerated ageing of seed (Singh, 1989).

Lipid peroxidation processes are considered as the primary cause of soybean (Glycine max (L.) Merr.) seed deterioration during ageing (Ferguson et al., 1990; Sung and Chiu, 1995) as the high lipid and protein content in soybean seeds make them prone to oxidative stress and is related to fast seed vigour decline with seed age. The ROS generated during ageing damages membrane bound organelles like mitochondria which lead to reduced mitochondria in cells and ultimately results in lower respiration and reduced seedling growth. (McDonald, 1999). However, degree of oxidative damage and capability of seed to resist negative aging consequences varies with varieties which contributes for maintaining seed vigour and viability during ageing. Initial EC of seed leachate of varieties/genotypes ranges from 61.7µS/gm in kalitur to 115.5 µS/gm in DS 228. Electrical conductivity of seed leachate was increased in all the varieties/genotypes. Highest EC was recorded in KDS 726 (293.9 µS/gm) after ageing which is on par with DS 228 and JS 71-05. Least EC was recorded in kalitur (118.1 µS/gm) after ageing, followed by MACS 1416 and DSB 21 (Table 2). During seed ageing, ROS accumulation and lipid peroxidation generate changes in the structural and functional properties of membrane lipids, which increase membrane permeability (Simon 1974). This loss of membrane integrity leads to electrolyte leakage, which increases the electrical conductivity of the seed leachate and is associated with viability loss in several species (Pukacka and Ratajczak, 2005).

Table 1: Effect of Accelerated Ageing on Seed Germination and Seedling Vigour in Soybean Varieties/Genotypes

Sl No.	Variety	Germination Per cent			Seedling Length (cm)			Seedling Vigour Index -I		
		Initial	Aged	Mean	Initial	Aged	Mean	Initial	Aged	Mean
1	MACS 1416	98(72.5)	47 (43.3)	72.5	36.2	26.3	31.3	3552	1236	2394
2	MAUS 612	92 (74.1)	36 (36.9)	64	36.9	25.5	31.2	3397	917	2157
3	EC 18761	99 (87.1)	42 (40.4)	70.5	36.7	27.8	32.3	3637	1169	2403
4	MAUS 61	95 (79.0)	5 (12.8)	50	42.2	20.7	31.4	4007	103	2055
5	MACS 1410	88 (69.9)	34 (35.7)	61	37.7	23.6	30.7	3318	803	2061
6	DSB 25	96 (80.1)	20 (26.5)	58	37.9	21.8	29.9	3642	436	2039
7	DSB 24	89 (71.2)	10 (18.4)	49.5	41.7	23.5	32.6	3712	235	1974
8	KBS 22-2009	97 (84.9)	36 (36.9)	66.5	42.9	28.4	35.6	4163	1022	2592
9	CO 1	93 (75.4)	39 (38.6)	66	41.1	32.3	36.7	3825	1259	2542
10	CO 2	92 (74.1)	22 (27.9)	57	40.5	24.1	32.3	3724	529	2127
11	JS 335	87 (68.9)	27 (31.3)	57	39.2	26.0	32.6	3414	701	2057
12	RKS 18	81 (64.4)	36 (36.8)	58.5	40.5	26.9	33.7	3283	968	2125
13	DSB 1	80 (63.5)	15 (22.6)	47.5	37.1	23.2	30.1	2966	347	1656
14	NRC 93	87 (69.4)	7 (15.1)	47	39.6	21.2	30.4	3446	148	1797
15	DSB 21	84 (66.6)	39 (38.6)	61.5	38.7	28.3	33.5	3248	1103	2176
16	JS 71-05	79 (62.8)	0 (0.0)	39.5	33.2	0.0	16.6	2625	0	1313
17	DS 228	83 (65.8)	3 (9.7)	43	34.5	16.0	25.3	2864	48	1456
18	EC 30221	93 (75.1)	38 (38.0)	65.5	39.0	26.5	32.7	3624	1008	2316
19	KDS 726	86 (68.30	13 (21.1)	49.5	36.5	20.8	28.7	3141	270	1706
20	CO 3	96 (82.0)	28 (31.9)	62	43.7	28.3	36.0	4198	794	2496
21	JS 20-34	92 (73.6)	29 (32.5)	60.5	36.0	23.3	29.7	3313	676	1994
22	JS 95-60	85 (67.3)	20 (26.5)	52.5	37.1	23.3	30.2	3151	466	1808
23	EC 481205	86 (68.1)	12 (20.1)	49	40.3	24.0	32.2	3468	288	1878
24	JS 97-52	89 (71.2)	30 (33.3)	59.5	42.8	27.5	35.1	3807	824	2316
25	2758	85 (67.4)	29 (32.5)	57	38.6	23.5	31.0	3277	682	1979
26	Kalitur	94 (76.2)	52 (46.2)	73	45.0	30.0	37.5	4231	1563	2897
27	DS 9814	82 (65.0)	12 (19.9)	47	36.6	22.8	29.7	3005	274	1639
28	ADT 1	84 (66.5)	16 (23.4)	50	43.1	24.4	33.8	3623	390	2007
29	JS 2029	85 (67.3)	29 (32.5)	57	37.4	23.8	30.6	3183	690	1936
30	JS 20-50	81 (64.2)	21 (27.0)	51	36.4	21.8	29.1	2944	457	1701
Mean		**88.6**	**24.9**	**56.75**	**39.0**	**23.8**	**31.4**	**3460**	**647**	**2053**
Source of Variation			**SEd**	**CD (P=0.05)**	**SEd**	**CD (P=0.05)**		**SEd**	**CD (P=0.05)**	
Variety (V)			2.03	4.01	**0.82**	**1.66**		93.23	183.96	
Ageing (A)			0.52	1.03	0.217	0.42		24.07	47.5	
VxA			2.87	5.67	1.19	2.35		131.84	260.17	

**- values in the parenthesis are arc sine transformed values*

Table 2: Effect of Accelerated Ageing on Seedling Vigour and EC of Seed Leachate in Soybean Varieties/ Genotypes

Sl No.	Variety	Seedling Dry Weight (mg/Seedling)			Seedling Vigour Index -II			EC (µS cm^{-1} g^{-1})		
		Initial	Aged	Mean	Initial	Aged	Mean	Initial	Aged	Mean
1	MACS 1416	47.0	34.2	40.6	4608	1605	3107	82.0	152.4	117.2
2	MAUS 612	47.3	32.4	39.8	4349	1166	2757	84.9	178.5	131.7
3	EC 18761	43.0	31.9	37.5	4257	1341	2799	84.7	162.8	123.8
4	MAUS 61	47.2	22.6	34.9	4479	113	2296	100.5	283.5	192.0
5	MACS 1410	46.2	28.4	37.3	4061	966	2514	92.8	175.8	134.3
6	DSB 25	42.0	23.2	32.6	4027	465	2246	95.0	202.7	148.8
7	DSB 24	47.3	27.5	37.4	4210	275	2242	107.5	257.4	182.4
8	KBS 22-2009	46.7	29.5	38.1	4532	1063	2798	86.3	169.2	127.7
9	CO 1	40.0	30.6	35.3	3720	1191	2456	88.5	172.6	130.6
10	CO 2	37.5	23.5	30.5	3452	516	1984	95.3	210.5	152.9
11	JS 335	49.9	36.6	43.2	4337	987	2662	88.3	198.4	143.4
12	RKS 18	51.7	34.9	43.3	4184	1256	2720	82.2	176.8	129.5
13	DSB 1	42.5	25.3	33.9	3402	380	1891	96.3	218.9	157.6
14	NRC 93	49.7	25.0	37.3	4322	175	2248	100.3	251.0	175.6
15	DSB 21	47.0	33.4	40.2	3950	1303	2626	80.4	158.7	119.5
16	JS 71-05	42.6	0.0	21.3	3365	0	1683	114.1	287.3	200.7
17	DS 228	45.6	19.6	32.6	3781	59	1920	115.5	291.3	203.4
18	EC 30221	41.4	27.0	34.2	3853	1026	2439	87.7	183.1	135.4
19	KDS 726	62.1	26.7	44.4	5338	347	2843	109.3	293.9	201.6
20	CO 3	34.4	20.6	27.5	3302	575	1939	93.9	194.7	144.3
21	JS 20-34	32.7	23.0	27.9	3011	667	1839	92.6	186.5	139.5
22	JS 95-60	30.3	19.1	24.7	2571	382	1477	98.2	212.6	155.4
23	EC 481205	41.5	20.4	30.9	3565	245	1905	89.9	189.8	139.8
24	JS 97-52	33.9	24.0	28.9	3013	720	1866	86.8	177.7	132.3
25	2758	39.7	27.8	33.7	3370	805	2088	77.8	183.4	130.6
26	Kalitur	46.9	31.0	39.0	4407	1622	3015	61.7	118.1	89.9
27	DS 9814	45.3	24.1	34.7	3713	290	2001	95.9	225.8	160.9
28	ADT 1	44.1	21.8	33.0	3704	349	2027	101.8	218.1	159.9
29	JS 2029	32.8	23.2	28.0	2620	673	1646	90.2	189.7	140.0
30	JS 20-50	30.2	19.1	24.7	2448	401	1424	98.1	208.7	153.4
Mean		**42.9**	**25.5**	**34.2**	**3798**	**699**	**2249**	**92.6**	**204.3**	**148.5**

Source of Variation	SEd	CD (P=0.05)	SEd	CD (P=0.05)		SEd	CD (P=0.05)	
Variety (V)	1.85	3.66	146.82	289.73		5.59	11.04	
Ageing (A)	0.47	0.94	37.91	74.8		1.44	2.85	
VxA	2.62	5.18	207.64	409.74		7.91	15.61	

CONCLUSIONS

The varieties/genotypes tested shown wide variability in ability to germinate and produce vigorous seedlings after accelerated ageing of 7 days which might be due to varied capability of varieties to resist negative ageing changes. Out of 30 varieties/genotypes tested, Kalitur, MACS 1416, DSB 21, EC 18761 and CO1 were found to maintain maximum seed quality attributes after accelerated ageing for 7 days, while JS 71-05, DS 228, MAUS 61, NRC 93 and DSB 24 were found to be poor storers.

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